Physical Endurance of Rats Increased by Rutin

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Evidence has accumulated in the literature which indicates that rutin (Nutritional Biochemical Corporation), a constituent of several plant species, might increase the resistance of animals to physical exhaustion. Akamatsu (1931) reported that rutin increased the amplitude of the heart beat and increased the minute volume of both intact and isolated frog hearts. DeEds and Couch (1948) also reported stimulation of frog hearts with rutin and Fukuda (1932) found that rutin increased heart action in rabbits. In addition, Teras (1964) reported that rutin had accelerating effects on the respiratory enzymes, succinic dehydrogenase and cytochrome oxidase. Acceleration of heart action and respiratory enzymes would appear to be key processes in the adjustment of the organism from the resting to the active state. Thus, the objective of this study was to determine whether rutin would increase the resistance of rats to physical exhaustion.

Swim tests have been used in a variety of experiments to evaluate the effects of treatments on physical performance (Tan, Hanson, and Richter, 1954; Werboff, Haggett, and Anderson, 1967) and was chosen for the present study. Thirty-six 100-day-old male rats were used. The rats were housed individually in wire mesh open bottom cages and fed a stock diet (Purina Laboratory Chow) prior to and during the 15 day experimental period. The experiment consisted of three phases: (a) a 5 day preconditioning period during which the rats were allowed feed and water *ad libitum*, (b) a one day period during which the treatments were administered and the swim trials conducted, and (c) a 9 day period during which the rats were observed for after effects.

Rutin is only slightly soluble in water and body fluids and easiest to administer to animals in the feed however, under these conditions it is difficult to control dosage. A stomach tube appears appropriate but there is some controversy regarding the efficiency of absorption of rutin from the gastrointestinal tract as only traces could be found in the urine compared with appreciable quantities when fed intravenously (Griffith, Krewson, and Naghski, 1955). Subcutaneous application has been found to be effective as rutin

appeared in the urine as rapidly as after intravenous injections (Griffith, Krewson, and Naghski, 1955). In a search for a solvent for topical application, rutin was found to be highly soluble in dimethyl sulfoxide (DMSO), which has been found to be effective for administering drugs that are relatively insoluble in water (Jacob, Bischel, and Herschler, 1964; Rosenkrantz, et al., 1963). Based on this evidence rutin was dissolved in DMSO and applied topically.

After the 5 day preconditioning period the rats were weighed in order to compute rutin dosage and an area approximately 5 cm in diameter on the back was shaved to permit topical application of the treatments, which were as follows: (a) normal control, (b) DMSO control, (c) DMSO+rutin. Dosage level for the DMSO+ rutin treatment was 75 mg rutin per kg of body weight. In order to give the DMSO alone at a comparable level with the DMSO used as a solvent in the rutin treatments, the dosage level was 91 per cent of the DMSO+rutin level. The rats were assigned at random to the above treatments. Six animals were used in the DMSO+rutin and normal control groups. Twelve rats were used in the DMSO group. Here in accordance with Dunnett's (Steel and Torrie, 1960) recommendations, 12 rats were used since this latter group represented a reference standard for evaluation of the two treatment groups. The treatments were applied twice during the day preceding the swim test, 15 hrs before and one hr prior to the swim test. This procedure was based on excretion data (Scarborough and Bacharach, 1949). The swim tests were carried out in a 55 gallon metal drum filled with water to a level 12 inches from the top. Water temperature was maintained at 18 ± 0.5 C by addition of ice. The ice was allowed to melt before the swim test. A weight handicap was provided by a lead collar 1 mm thick by 6 mm wide with the length adjusted to provide a weight equal to 4 per cent of the body weight. Swim time was measured with a stop watch. Testing ended when an animal remained submerged for 30 seconds. The rat was then removed from the water and returned to its cage for post-test observations. Body weight was followed for nine days to obtain a measure of after effects of the DMSO and DMSO+rutin treatments. Food and water were allowed *ad libitum* during this period. Statistical analysis of the data were carried out using Dunnett's test.

The results of the swim tests of the rats subjected to the DMSO

TABLE 1

Swim times and body weight for rats treated with DMSO alone or with DMSO + rutin

Treatment	No	Body wt (gms)		Swim time (min)		Post test wt change (gms*)
		Mean	SD	Mean	SD	Mean
Control	6	377	31	9.70	2.97	+2.3
DMSO	12	386	33	9.39	3.25	+3.9
DMSO + Rutin	6	394	23	12.67†	2.59	+5.3

*Net change during 9 days following swim test; no statistically significant difference
†Statistically significant difference at the $P<0.5$ level

and DMSO+rutin treatments are shown in Table 1. The mean swim time of the rutin treated rats was significantly longer ($P<0.05$) than that of the DMSO treated or normal controls. Body weights before and nine days after the test were not significantly different.

The results of the study confirms the evidence in the literature indicating that rutin might enhance physical performance. The 31 per cent increase in swim time of the rats administered rutin may indicate some usefulness for rutin in situations requiring a high level of energy output, especially since rutin has been reported to show an apparent lack of toxicity in the mammalian body (Griffith, Krewson, and Naghski, 1955).

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